Unit -1 (Solid state).

(*) Discuss the classification of solid?

Distinguish between crystalline solids and Amorphus solid or non-crystalline solid?

→ Based on arrangement of atom's in a Solid, there are three types of solid's —

(i) <u>Crystalline solid</u> :- In this type of solid's the atoms arrange in a regular and Periodic manar. We get an unique Patteren through out the crystal.

Ex :- NaCl, KCl, Quartz, Cu, Fe, etc.

(ii) <u>Semi- crystalline solid</u> :- In this type of Solid's the Particle's are arrange'd in random manere, but they have well define boundary's.

Ex :- Different types of rock's.

(iii) <u>Non- Crystalline / Amorphus solid</u> :- In this type of solid, there is no Particular boundary and the particle's are arranged in a random maner.

Ex :- glass.

Crystalline	Amorphus
(i) In crystalline solid particle are arranged in a periodic maner and there is an unique pattern throughout the crystal.	(i) In amorphus solid, particle's are arranged in a random maner.
(ii) Crystalline solid has different value's of physical properties like, thermal conductivity, electric conductivity, refrective index, in different direction. that's why they are called anisotropic.	(ii) Amorphus solid has same value of physical property in all direction, that's why they are called isotropic.
(iii) Crystalline solid has sharp melting point.	(iii) Amorphus solid has no sharp melting point.

(*) Define Lattice Point, Basis, Lattice vector, Lattice structure.

→ **Lattice Point:-** The imaginary point's in a crystal structure, which are arranged in regular pattern, called lattice point.

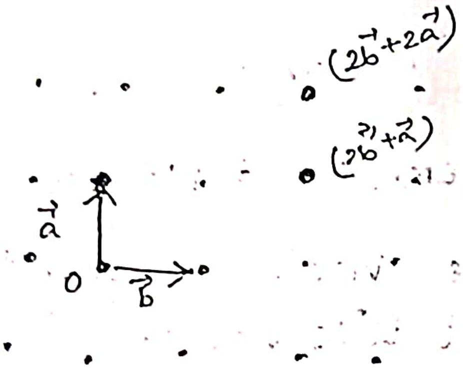
Basis:- the atom or group of atom, that are placed in lattice point to form the crystal structure is known as Basis.

A crystal can be monoatomic basis, (Cu, Fe), diatomic Basis (Kcl, Nacl), Polyatomic Basis(

Lattice structure / Crystal structure:- By Placeing the basis in crystral Point's/lattice point's we get a unique structure, which is known as lattice structure.

Lattice vector:- The vector's which describe the Periodic behaviour and the Position of Lattice Point's in a crystaline solid's is known as lattice vector.

Example:-



Here, $\vec{a}$ and $\vec{B}$ are lattice Vector.

(*) Define unit cell and Premitive cell?

→ The fundamental Pattern of minimum no of attom's or molecules, which represent all the charectaristic of the crystal and the repetation of this fundamental pattern in 3D we get the whole crystal structure is known as unit cell.

A Primitive cell is a minimum volume unit cell and only one lattice point in it.

(A) (B) [2-D]

Here, we consider, two 2-D unit cell 'A' and 'B'. No. of lattice point in A $= \frac{1}{4} \times 4 + 1$
$= 2$

So, it is not a primitive cell.

No. of lattice point in B $= \frac{1}{4} \times 4$
$= 1$

So, it is a primitive cell as well as a unit cell.

(*) What do you mean by crystal elements. classify different types of cubic crystal.

→ The lattice vectors and the angle between the lattice vectors is known as crystal elements.

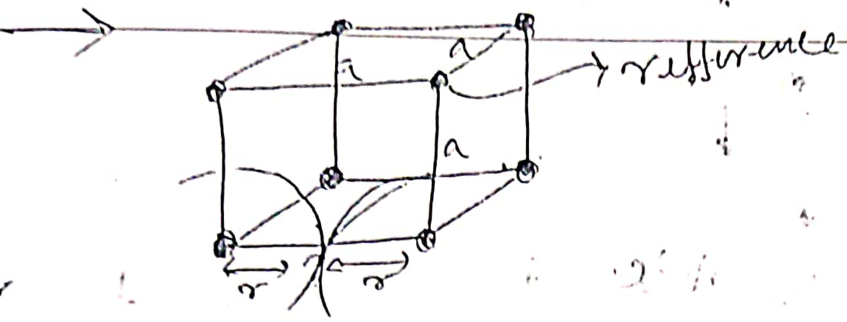
For Example :- In 3-D crystal, lattice vectors are denoted by $\vec{a}$, $\vec{b}$, $\vec{c}$ and the angle between them, α, β, γ.

for cubic crystal, $\alpha = \beta = \gamma = \pi/2$

$\vec{a} = \vec{b} = \vec{c}$

"there are 3-types of cubic lattice :-
(i) simple cubic (sc) (ii) Body centric cubic (bcc)
(iii) face centre cubic (fcc).

Q. (7) Find the nearest naighbour number / co-ordination number, 2nd nearest naighbour number, 1st nearest naighbour distance, 2nd nearest naighbour distance, Packing fraction for simple cubic.



Total no. of lattice point $= \frac{1}{8} \times 8 = 1$

i.e. Simple cubic unit cell is primitive.

The nearest naighbour distance $= a$.

where, [a = lattice const. = side of the cubic unit cell.

the nearest naighbour number or co-ordination no. $= 6$

2nd nearst naighbour distance $= a\sqrt{2}$

2nd " " number $= 12$.

the relation between radius of atom and lattice side / lattice const. is given by $2r = a$.

Packing fraction $= \frac{\text{the amount of matterial inside the unit cell}}{\text{the volume of whole unit cell.}}$

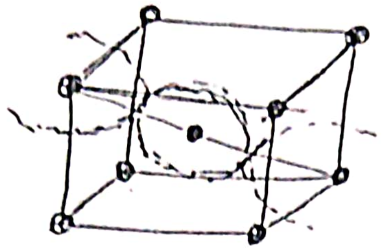
$$= \frac{1 \times \frac{4}{3}\pi r^3}{a^3}$$

$$= \frac{4\pi r^3}{3 \cdot 8 r^3} = 0.524$$

$= 52.4\%$

(*) Find, co-ordination number, 1st nearest naibour distance, 2nd nearest naibour distance, Packing fraction for body centric cube (bcc).

→



the total no. of lattice point = $\frac{1}{8} \times 8 + 1$

= 2.

nearest naibour distance = $\frac{a\sqrt{3}}{2}$ [a = side of the cube

nearest naibour number / co-ordination number = 8.

2nd nearest " distance = a.

2nd " " number = 6.

∴ relation between radius of atom and lattice const. ⇒ $4r = a\sqrt{3}$ ⇒ $a = \frac{4r}{\sqrt{3}}$

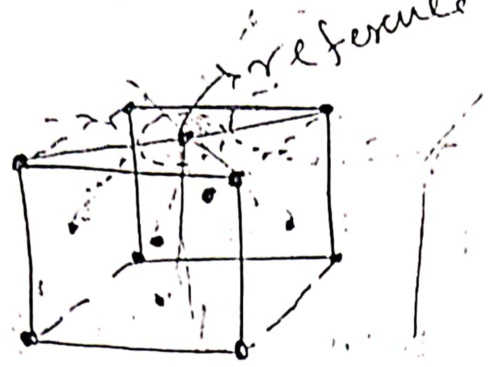
∴ Packing fraction = $\frac{2 \times \frac{4}{3} \pi r^3}{\frac{64 r^3}{3\sqrt{3}}}$

= 0.68

= 68 %

(*) Find co-ordination number, 1st, 2nd nearest distance, Packing fraction for face centric cube (fcc).

→



total no. of lattice Point $= \frac{1}{8} \times 8 + \frac{1}{2} \times 6$

$= 4.$

nearest naibourr distance $= \frac{a\sqrt{2}}{2}$ [a = side of the cube

co-ordination number = 12

2nd nearest naighbour distance = a.

2nd " " number = 6

∴ relation between radius of atom and lattice const. $4r = a\sqrt{2}$, ⇒ $a = \frac{4r}{\sqrt{2}}$

∴ Packing fraction $= \frac{4 \times \frac{4}{3} \pi r^3}{2 \sqrt{2} \frac{64 r^3}{2\sqrt{2}}}$

$= 0.74$

$= 74\%$

(*) show that, Packing faction of fcc is graater than, bcc and sc.

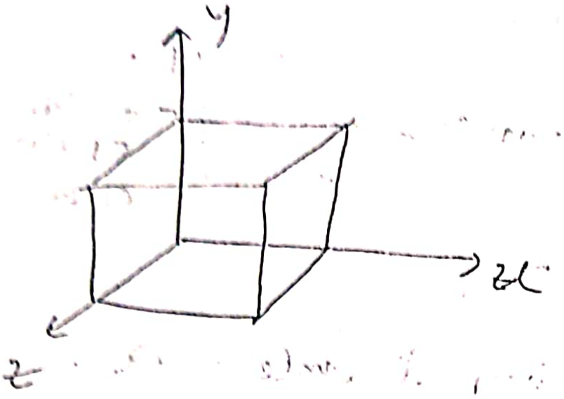
→ Sum of 1st, 3rd question.

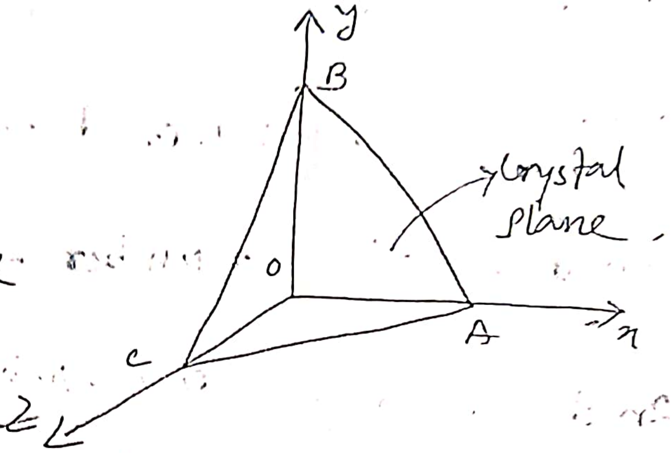
(hkl)

(i) What do you mean by miller indices. Wri... down the significance of miller indices.

→ In a crystal structure (many) three dimentional plane's are consider to describe the crystal structure. each crystal plane contain's lattice point in it.

To identify each crystal plane we use a technique called miller indeces.





We consider a crystal plain ABC that cutt's x-axis at point 'A', y-axis at point 'B', and z axis at point 'c'.

let, a, b, c are lattice side / const.

then, Miller indeces of the plain,

$$h : k : l = \frac{a}{OA} : \frac{b}{OB} : \frac{c}{OC}$$

for a simple cubic system, a crystal plain cutt's, x, y, z-axis at distance 2Å, 4Å, 6Å

the miller indeces of the plain,

$$h : k : l = \frac{a}{2} : \frac{a}{4} : \frac{a}{6}$$

$: \frac{1}{3} : \frac{1}{?} : \frac{1}{6}$

$(hkl) - 6 : 3 : 2$

$(hkl) : (6\,3\,2)$

(*) For a lattice system a : b : c = 2 : 3 : 4, a crystal plain cutt's x, y, z axis at distance 4Å, 6Å, 8Å. Find Miller indices of the plain.

→ $h : k : l = \frac{2}{4} : \frac{3}{6} : \frac{4}{8}$

$= \frac{1}{2} : \frac{1}{2} : \frac{1}{2}$

$= 1 : 1 : 1$

$\therefore (hkl) = (111)$

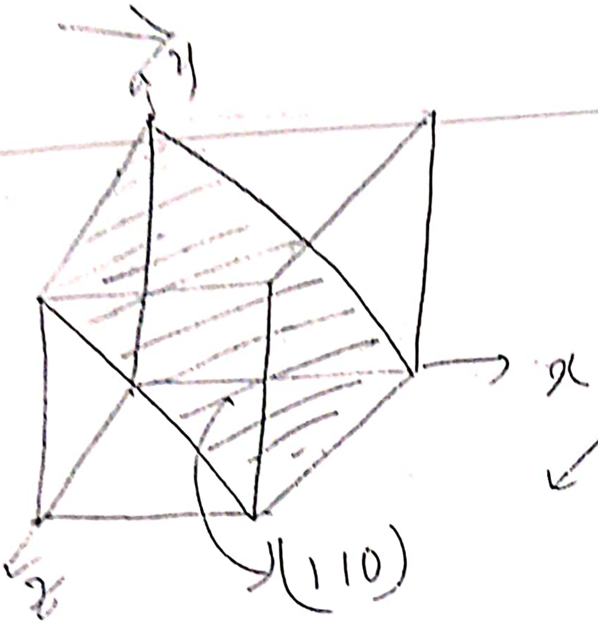
(**) In a crystal system a : b : c = 1 : 2 : 3, a crystal plain cutt's x, z axis at distance 2Å, 6Å respectively, and parralel to y axis. Find Miller indices of the plain.

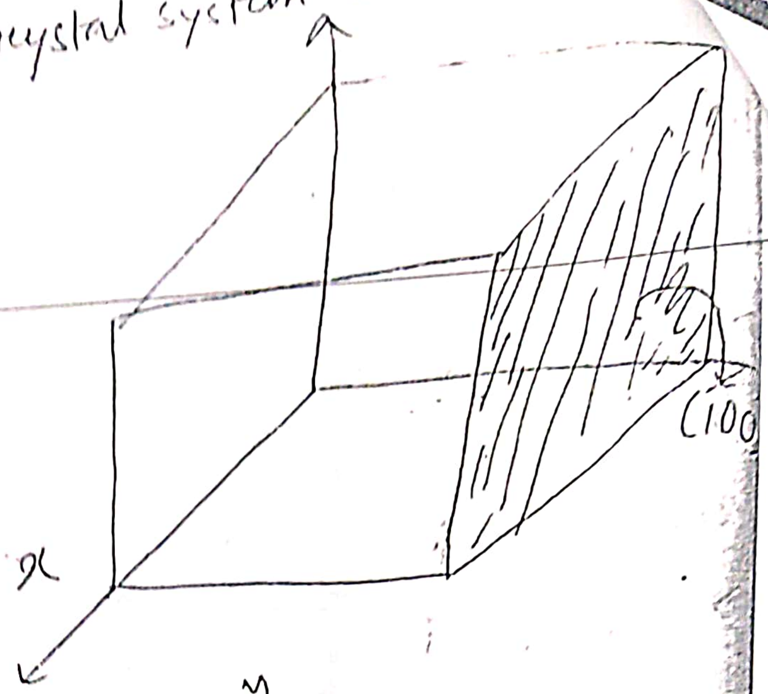
→ $h : k : l = \frac{1}{2} : \frac{2}{\infty} : \frac{3}{6}$

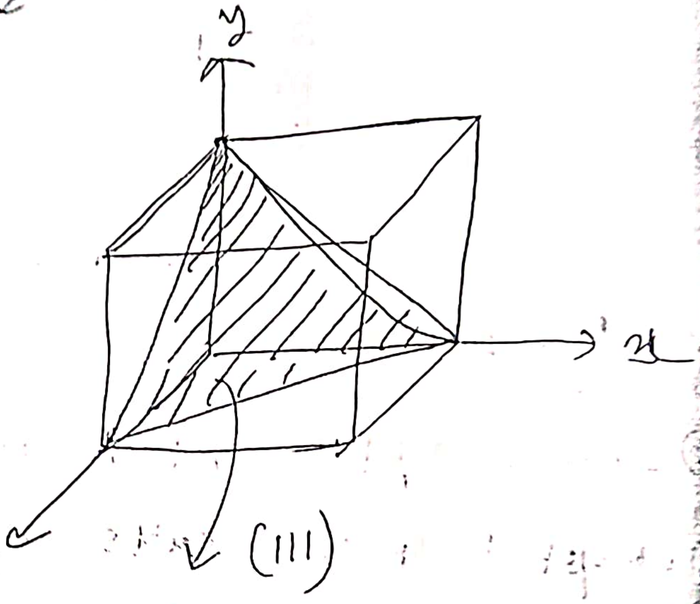
$= 1 : 0 : 1$

$(hkl) = (101)$

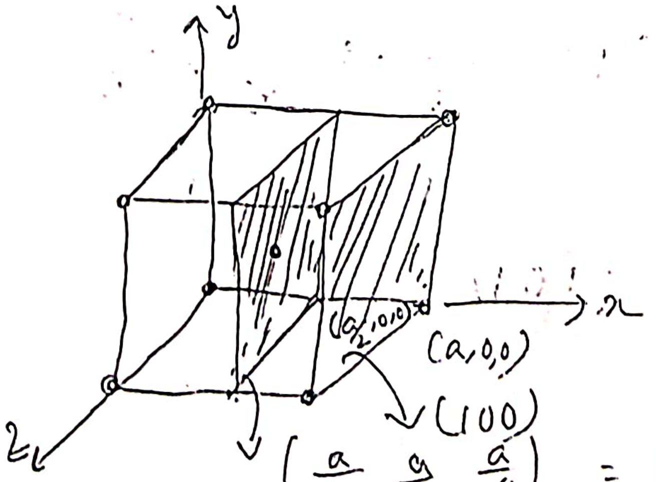
(P) For a cubic crystal system ... (111) plane.







Note:- Parallel crystal planes have same miller indices. For Example:-



Here, a = lattice const.

$\left(\frac{a}{a/2}\ \frac{a}{\infty}\ \frac{a}{\infty}\right) = (200) = (100)$

Q) Find a relation between density of a crystal lattice const.

→ We consider a unit cell of volume V, ρ is the density of the crystal material.

~~Let, n is the number of atom per unit cell.~~

M is the molar mass of the material.

N_A is Avogardro number.

We know that,

N_A no. of atom has mass $= M$.

$\therefore 1$ " " $= \frac{M}{N_A}$

$$\rho = \frac{Mass}{Volume}$$

$$\rho = \frac{\frac{M}{N_A} \cdot n}{V}$$

$$\rho = \frac{nM}{N_A V}$$

for, cubic lattice $V = a^3$

$$\boxed{\rho = \frac{nM}{N_A a^3}}$$

This is the relation between density and lattice parameter.

(*) Density of Fe is 7800 Kg/m³. If the crystal structure of Fe is FCC find lattice const. of Fe.

$4r = a\sqrt{2}$

→ $$\rho = \frac{4 \times 56}{N_A a^3}$$

$$\Rightarrow 7800 = \frac{4 \times 56 \times 10^{-3}}{6.022 \times 10^{23} a^3} \Rightarrow a^3 = 0.47 \times 10^{-28}$$

$\Rightarrow a^3 = 0.047 \times 10^{-27}$

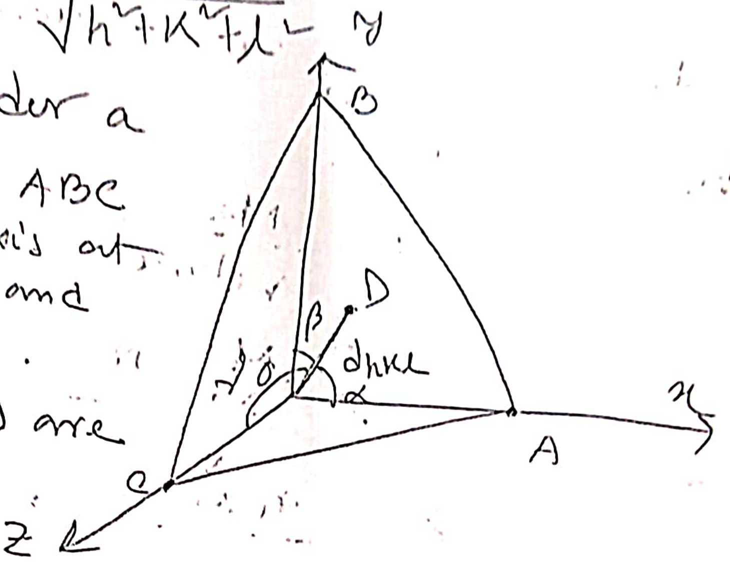
$a = 0.360 \times 10^{-9}$ m

$= 3.60\ \mathring{A}$

*** (*) Show that inter plainer spacing between two parallel plain having Miller indices (h.K.l), $d_{hkl} = \dfrac{1}{\sqrt{\frac{h^2}{a^2}+\frac{K^2}{b^2}+\frac{l^2}{c^2}}}$

Hence show that for cubic lattice $d_{(hkl)} = \dfrac{a}{\sqrt{h^2+K^2+l^2}}$

→ We consider a crystal plane ABC cutt's x, y, z axis at distance, OA, OB and OC. respectively.



The lattice sides are a, b, c. let, another crystal plane parallel to ABC crystal plane passing through origin O. the miller index of the crystal plane is (hkl).

$h = \dfrac{a}{OA}$, $K = \dfrac{b}{OB}$, $l = \dfrac{c}{OC}$

OD = d_{hkl} = Perpendicular distance between two parallel plane.

Let. α, β, γ are the angles between made by OP with x, y, z axis respectively.

$$\cos\alpha = \frac{OP}{OA} \Rightarrow \cos\alpha = \frac{d_{hkl}}{(a/h)}$$

Similarly,

$$\cos\beta = \frac{d_{hkl}}{b/k}, \quad \cos\gamma = \frac{d_{hkl}}{c/l}$$

We know that,

$$\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$$

$$\Rightarrow \frac{d^2_{hkl}}{a^2/h^2} + \frac{d^2_{hkl}}{b^2/k^2} + \frac{d^2_{hkl}}{c^2/l^2} = 1$$

$$\Rightarrow d_{hkl} = \frac{1}{\sqrt{\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}}}$$

for cubic, lattice,

$$a = b = c.$$

$$\boxed{d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}}$$

⊛ Find the inter planar spacings of $d_{100}, d_{110}, d_{111}$, for simple cubic crystal having side 2Å

→ Here, crystal structure is a cubic and lattice side is 2Å.

we know the inter planar spacing,

$$d_{hkl} = \frac{a}{\sqrt{h^2+k^2+l^2}}$$

$$\therefore d_{100} = \frac{2}{\sqrt{1+0+0}} = 2\,\text{Å}$$

$$\therefore d_{110} = \frac{2}{\sqrt{1+1+0}} = \sqrt{2}\,\text{Å}$$

$$\therefore d_{111} = \frac{2}{\sqrt{1+1+1}} = \frac{2}{\sqrt{3}}\,\text{Å}$$

(*) i) why difrection of x-ray is not possible using diffraction grating?

ii) why difrection of x-ray is possible by using a crystal?

→ (i) We know that the most ~~important~~ necessary condition for diffrection of light is that, the size of the slit must be compareable to wave length of light.

In difrection grating the slit width is verry greater than wave length of x-ray. that's why difrection of x-ray is not possible using difrection grating.

(ii) We know that, the crystal structure has an unique pattern and the distribution of atom's are regular. The distance between two consiqutive crystal plane is compare able to wave length of x-ray. That is why difrection of x-ray is

...ossible by using a crystal?

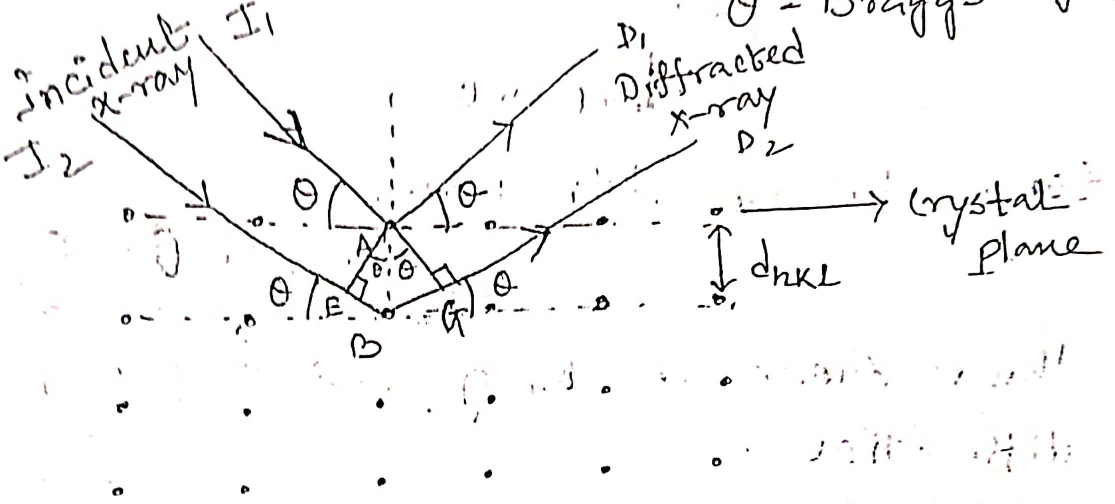
Q) State and Proof bragg's law of x-ray diffraction.

→ The condition for constructive diffraction (Difraction maxima) Produced by crystal plane of miller indices (hkl) for x-ray of wavelength λ is given by.

$$2d_{hkl}\sin\theta = n\lambda, \quad n = 1, 2, 3 \ldots$$

θ = Bragg's angle.

Proof:-



Bragg's consider that each of the parallel crystal plain act as reflecting surface. let a parallel beam of x-ray incident on parallel crystal plains at angle 'θ' w.r.to crystal plain. 'θ' is known as bragg's angle or glancing angle.

d_{hkl} = distance between two consequetive parallel crystal plain.

We draw two perpendicular's AE and AG on I_2B and BD_2 to find the path difference between this two x-ray

from Δ AEB,

$EB = AB \sin\theta$

$\Rightarrow EB = d_{hkl} \sin\theta$

Similarly, $BG = AB \sin\theta$.

$\Rightarrow BG = d_{hkl} \sin\theta$

So, the Path difference between this two x-ray

$\Delta = EB + BG$

$= 2 d_{hkl} \sin\theta$

For constructive difrection,

$$2 d_{hkl} \sin\theta = n\lambda,$$

$n = 1, 2, 3 ---$

- this is Known as Bragg's law of x-ray differection.

(*) **Note :-** Diffraction angle = $2\theta_i = 2 \times$ bragg's angle

(*) In a simple cubic crystal system constructive diffrection is observe form (211) plane. if the wave length of x-ray is $0.4 \mathring{A}$ and differention angle $60°$. Find lattice const. of the cristal.

→ Here, $2\theta = 60°$. $\theta = 30°$.

from Bragg's law,

n = 1] take,

$2 d_{hkl} \sin\theta = n\lambda,$

$\Rightarrow 2 \times d_{(211)} \frac{1}{2} = 0.4$

$\therefore d_{(211)}$

For simple cubic,

$$d_{(211)} = \frac{a}{\sqrt{2^2+1^2+1^2}}$$

$$\Rightarrow 0.4 = \frac{a}{\sqrt{6}}$$

$$\therefore a = 0.4\sqrt{6}\ \text{Å}$$

$$\Rightarrow a = 0.9798\ \text{Å}$$

(*) A simple cubic crystal system 2nd order constructive diffraction is observe at diffraction angle 90°. If the wave length of x-ray is 1Å, find the density of the crystal. (molar mass of sc crystal = 64 gm). given, $d_{hkl} = (111)$.

→ Here, $2\theta = 90°$. $\Rightarrow \theta = 45°$

$n=2$ ∴ $2 d_{hkl} \sin 45° = \lambda$

$$\Rightarrow d_{hkl} = \sqrt{2}\ \text{Å}$$

$$\therefore \sqrt{2} = \frac{a}{\sqrt{3}}$$

$$\Rightarrow a = \sqrt{6}\ \text{Å}$$

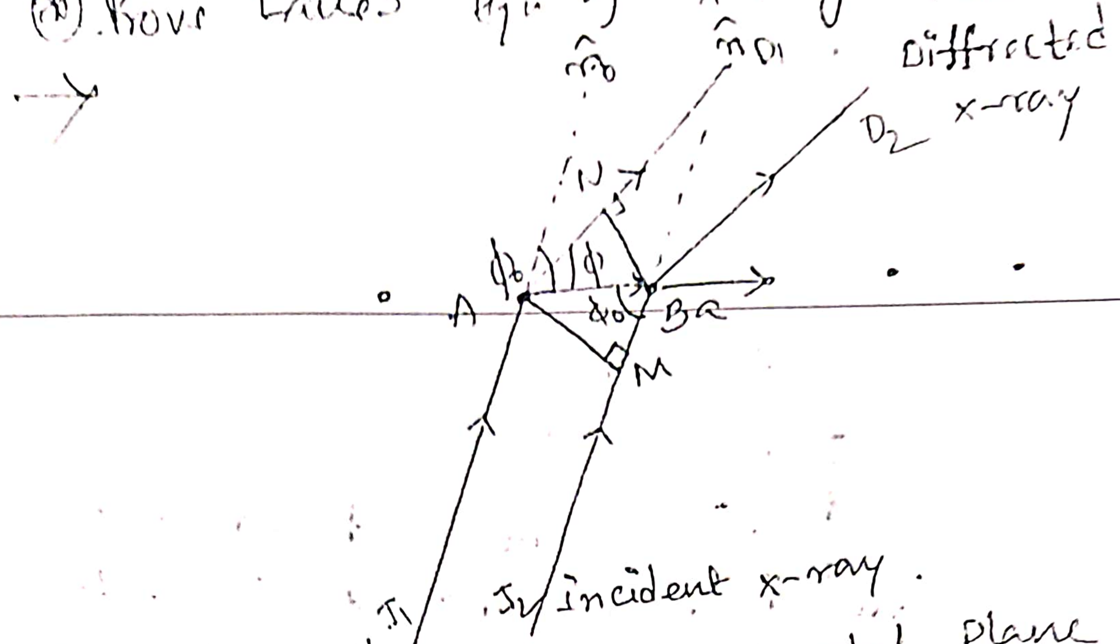
$$\therefore \text{density}(\rho) = \frac{M}{N_A\, a^3}$$

$$= \frac{64\times10^{-3}}{6.022\times10^{23}\times 6\sqrt{6}\times10^{-30}}$$

$$= 0.7231\times10^{4}\ \text{kg/m}^3$$

$$= 7231\ \text{kg/m}^3.$$

(iii) Prove Laue's eqn of X-ray difrection.



In Laue's diffrection the crystal plane behave as reffrection surface.

Here, ϕ_0 = angle between crystal plane and direction of incident x-ray.

ϕ = angle between crystal plane and diffrected x-ray.

a = lattice const (distance between two consequetive atom.)

to find the path difference between two incident x-ray, we draw perpendicular's on J_2 B and AD_1.

from figure,

$$MB = a \cos \phi_0$$

$$AN = a \cos \phi$$

the path diffetence between this two x-ray

$$\Delta = MB - AN = a(\cos \phi_0 - \cos \phi)$$

... in direction.

$\Delta = p\lambda$

$\Rightarrow a(\cos\phi_0 - \cos\phi) = p\lambda$ —— (i)

$\Rightarrow \boxed{\vec{a}\cdot\hat{m}_0 - \vec{a}\cdot\hat{n} = p\lambda}$, $p = 1, 2, 3, \ldots$

→ (ii)

$\hat{m}_0$ = unit vector in the direc^n of incident x-ray,
$\hat{n}$ = unit vector in the direc^n of diffracted x-ray.

equ^n (i) is known as Laue's equ^n of x-ray diffraction. and equ^n (ii) represent vector form of Laue's equ^n.

(*) Why x-ray diffraction by crystal is important.

(*) Write down advantages and disadvantages of bragg's and Laue's diffraction of x-ray.

→ advantages of bragg's law:
Bragg's law have huge application in material science.
To know the internal structure of material.

disadvantages:

(i) we cannot measure the intensity of diffraction maxima using bragg's law of x-ray diffraction.

(ii) Bragg's Law of x-ray Diffraction can not able explain why there is no-maxima for same crystal plane in specific crystal.

Advantages of Laue's diffraction :-

(i) It can be used for analysing specimens that are thick and large.

(ii) Laue method diffraction is used for the determination of orientation of crystal that a large and single. It was the first method of diffraction that was used.

(iii) White colour radiation from an x-rays transmitted or reflected by crystal by Laue method.

Disadvantages of Laue's method

This method are that it cannot be used for quantitative analysis because the wavelength of x-ray beam that is causing specific spot is unknown. Also required a large crystal analysis.

(*) X-ray diffraction crystal is important :-

X-ray diffraction is a non-destructive solid technique for delineating crystalline materials. It gives information on phases, structures, favored crystal orientations (texture), and different structure parameters such as strain, crystallinity, medium, grain size, and crystal cracks.

③ Q) From Laue's diffraction equation derive Bragg's law of X-ray diffraction.

→ From Laue's eqn of x ray diffraction,

$$a(\cos\alpha - \cos\alpha_0) = p\lambda \longrightarrow (i).$$

In 3-D crystal, ...

$$a(\cos\alpha - \cos\alpha_0) = p\lambda$$

$$b(\cos\beta - \cos\beta_0) = q\lambda \longrightarrow (ii)$$

$$c(\cos\gamma - \cos\gamma_0) = r\lambda \longrightarrow (iii).$$

where, p, q, r are Integer, 1, 2, 3, ...

Squaring eqn (i), (ii), (iii). and then adding them side by side we get

$$a^2(\cos\alpha - \cos\alpha_0)^2 + b^2(\cos\beta - \cos\beta_0)^2 + c^2(\cos\gamma - \cos\gamma_0)^2 = (p^2+q^2+r^2)\lambda^2$$

For. cubic cristal $a = b = c$,

$$\Rightarrow a^2[\cos^2\alpha - 2\cos\alpha\cos\alpha_0 + \cos^2\alpha_0 + \cos^2\beta + \cos^2\beta_0 - 2\cos\beta\cos\beta_0 + \cos^2\gamma + \cos^2\gamma_0 - 2\cos\gamma - \cos\gamma_0] = \lambda^2(p^2+q^2+r^2)$$

$$\Rightarrow a^2[2 - 2\cos\alpha\cos\alpha_0 - 2\cos\beta\cos\beta_0 - 2\cos\gamma\cos\gamma_0] = \lambda^2(p^2+q^2+r^2)$$

$$\Rightarrow 2a^2[1 - (\cos\alpha\cos\alpha_0 + \cos\beta\cos\beta_0 + \cos\gamma\cos\gamma_0)] = \lambda^2(p^2+q^2+r^2)$$

$$\Rightarrow 2a^2[1 - \cos\phi] = \lambda^2(p^2+q^2+r^2)$$

where, ϕ = diffraction angle.

where, $\cos\phi = \cos\alpha\cos\alpha_0 + \cos\beta\cos\beta_0 + \cos\gamma\cos\gamma_0$.

$\Rightarrow 2a^2 \cdot 2\sin^2\frac{\phi}{2} = \lambda^2(p^2+q^2+r^2)$

$\Rightarrow 4a^2 \sin^2\frac{\phi}{2} = \lambda^2(p^2+q^2+r^2)$

$\Rightarrow 2a\sin\frac{\phi}{2} = \lambda(p^2+q^2+r^2)^{1/2}$ ⟶ (iv)

We know that diffraction angle = 2 × Bragg's angle.

$\therefore \phi = 2\theta$.

$\Rightarrow \theta = \frac{\phi}{2}$.

from equ^n (iv),

$2a\sin\theta = \lambda(p^2+q^2+r^2)^{1/2}$

Let. $p = nh$, $q = nK$, $r = nl$, where n = +ve integer.

from eq^n (iv),

$2a\sin\theta = n\lambda(h^2+k^2+l^2)^{1/2}$

$\Rightarrow \frac{2a}{\sqrt{h^2+k^2+l^2}}\sin\theta = n\lambda$

$\Rightarrow 2d_{hkl}\sin\theta = n\lambda$. ⟶ (v)

equ^n (v) is known as bragg's diffraction equ^n.

from, the above expression we can define the laue's diffraction with integer p, q, r as nth order bragg's

diffraction from crystal during ... (hkl).

(*) Two different x-ray is used in crystal diffraction the diffraction angle/s are 30°, 45° respectively if the wave length of x-ray is 0.2 Å and 1 Å respectively find the density ratio of this two crystal? [mass no. are 64 and 56 respectively]

→

$\rho_1 = \frac{n M}{N_A \times a^3}$, $2 d_{hkl} \sin 15° = 0.2$

$\therefore d_{hkl} = \frac{0.1}{\sin 15°}$

$= \frac{1 \cdot 64 \times 10^{-3}}{6.022 \times 10^{-23} \times (0.69)^3}$ ⇒ $a = \frac{0.1 \sqrt{2}}{0.258}$

$a = 0.69$ Å

$= \frac{64 \times 10^{-3}}{N_A \times (0.69)^3}$

$2 d_{hkl} \sin(22.5) = 1$

$\therefore d_{hkl} = \frac{0.5}{0.39}$

$\rho_2 = \frac{56 \times 10^{-3}}{N_A \times (2.22)^3}$ ⇒ $a = 2.22$ Å

$\therefore \frac{\rho_1}{\rho_2} = \frac{64 \times (2.22)^3}{(0.69)^3 \times 56}$

$= 38.06$

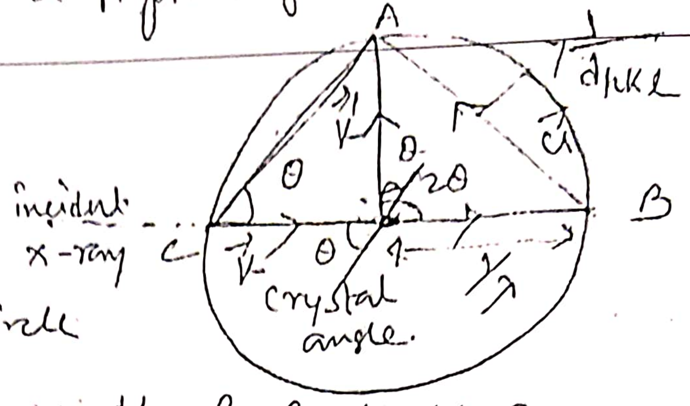
(*) Write down the vector form of bragg's eqn and Explain the geometrical interpretation of Bragg's eqn?

→ we know that bragg's eqn is given by $2 d_{hkl} \sin\theta = n\lambda$

$\frac{\sin\theta}{n} = \sin\theta_{hkl}$

⇒ $\frac{\sin\theta}{n} = \frac{\lambda}{2 d_{hkl}}$ ⇒ $\sin\theta_{hkl} = \frac{\frac{1}{d_{hkl}}}{2/\lambda}$ ---(i)

from the simple geometry we know that, a triangle inscribed inside a circle, which diameter along the hypotaneous of the triangle is a right angle triangle.



let, us consider a circle of diameter $\frac{2}{\lambda}$

Component :: the Perpendicular

$AB = \frac{1}{d_{hkl}}$

Here, θ = bragg's angle.

$\frac{1}{d_{hkl}}$ = is known as reciprocal lattice vector,

$\vec{G} = \frac{1}{d_{hkl}}$

the whole Geometrical representation can be stated at brifly as ——— (i) imagine the crystal plane to be at the centre of a circle of radius $\frac{1}{\lambda}$, where λ = wave length of x-ray.

(ii) at point B, where x-ray beam lead the crystal without any diffraction is the origin of reciprocal lattice vector.

(iii) when ever reciprocal lattice vector intersect the circle of radius $\frac{1}{\lambda}$, the bragg's condition is satisfied.

in figure, $\vec{K}$ and $\vec{K'}$ is incident and reflected wave vector.

from figure,

$$\vec{CO} = \vec{K},$$

again, $\vec{CO} + \vec{OB} = \vec{K'}$

using vector triangle law, $\boxed{\vec{K} + \vec{G} = \vec{K'}}$ → (11)

For elastic collision, there is no change in momentum.

so, $|\vec{K}| = |\vec{K'}|$

squareing both side of eqn (11), we get,

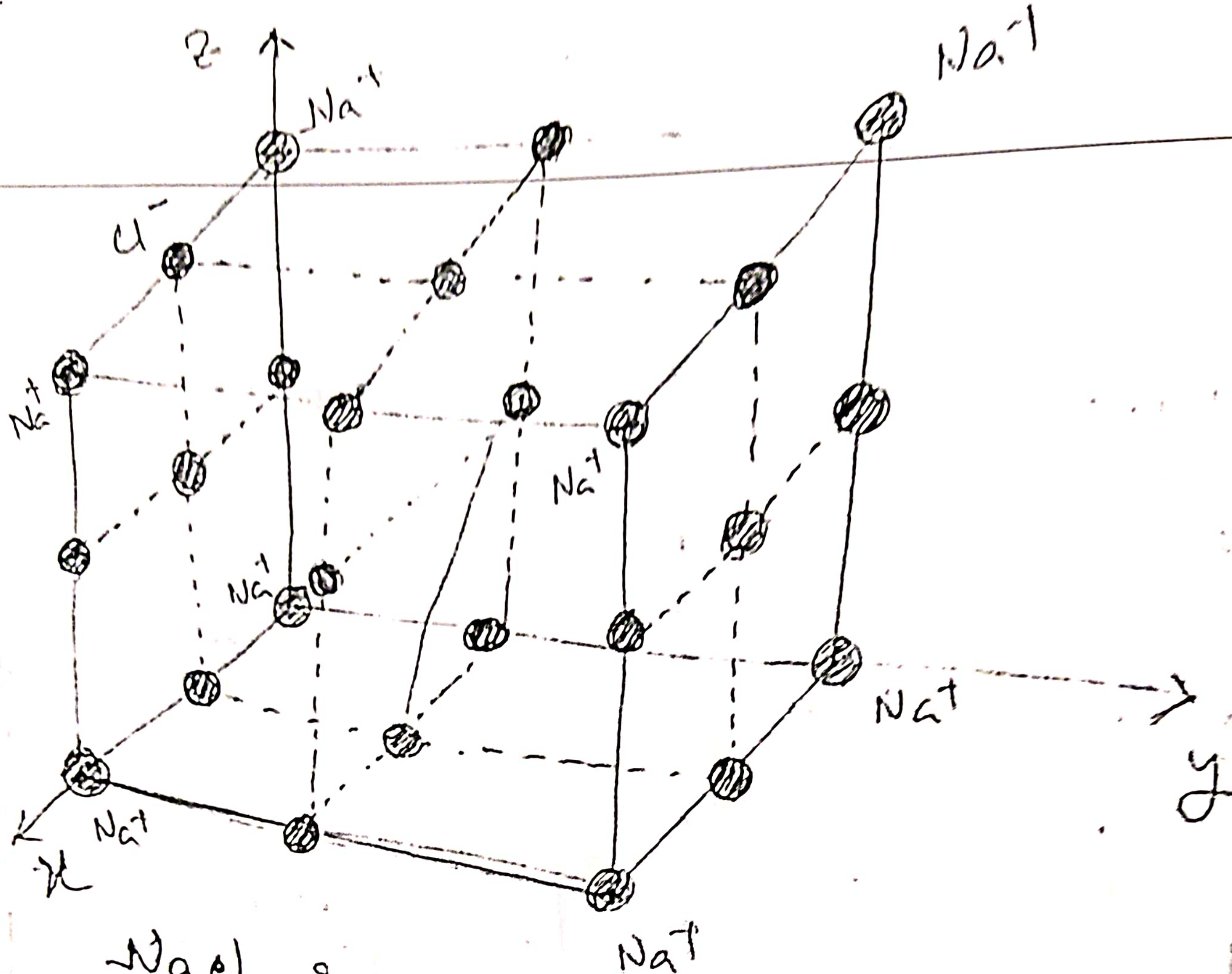
$$K^2 + 2\vec{K}\cdot\vec{G} + G^2 = K'^2$$

$$\Rightarrow \boxed{G^2 + 2\vec{K}\cdot\vec{G} = 0}$$

this is known as vector form of bragg's eqn.

(*) Explaine, the structure of sodium cloride with proper diagram :-

→ in NaCl structure Na atom's are +ve-ly charged and the cloride ione's are -vely charged the NaCl structure is formed due to electrostatic attraction between Na^+ and Cl^-. i.e NaCl is an ionic cristal.



NaCl is a face centre cubic crystal with two atomi basis.

The unit cell of NaCl there are four Na+ and 4 Cl- ione's

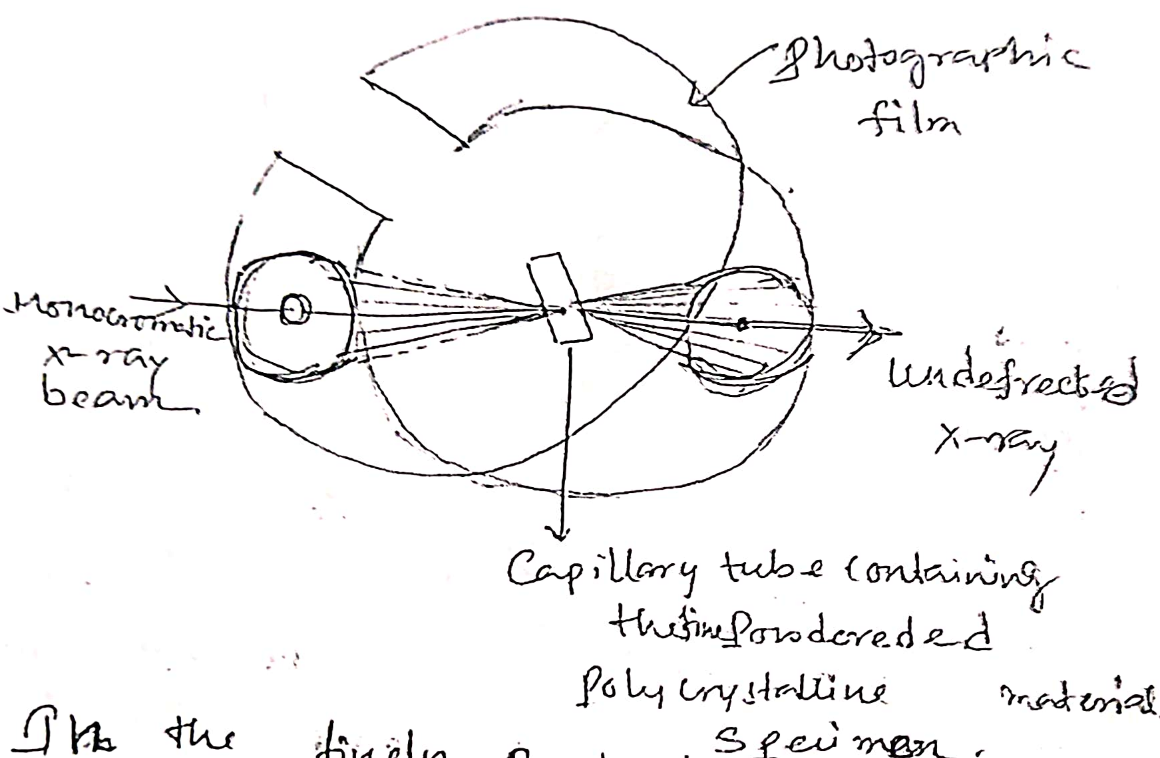
(*) Explain the structure of KCl with diagram:-
→

(*) Write down the importance of reciprocal lattice vector?

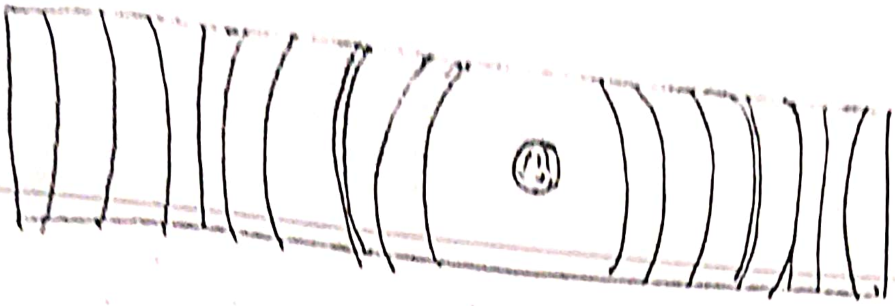
→ The reciprocal lattice plays a very fundamental role in most analytic in the theory of diffraction. in neutron and x-ray diffraction, due to the laue conditions, the momentum differece between incoming and diffraction x-rays of a crystal is a reciprocal lattice vector.

(i) Powder Method of X-ray diffraction :-

This Method was devised by Debye and scherrer in 1916 to determine the structure of finely Powdered Polycristalline materials. this Powdered material is kept inside the capillary tube. A narrow beam of monochromatic X-rays is allowed to fall on the Capillary tube.



In the finely Powdered Polycrystalline material specimen these are many crystals so we have different value of θ, X-rays are diffracted only when Bragg's law equ^n^ $2d\sin\theta = n\lambda$ is satisfied. The beam of X-ray are made monochromatic using a filter. A Photographic film is used to achives the diffracted X-rays.



Diffraction Pattern

Advantages :-

1. Identification of unknown Crystalline material.
2. Determination of unit cell dimensions.
3. Measurement of sample's Purity.
4. It helps to determine lattice Parameters a, b,

reciprocal

$$\vec{a}^* = \frac{\vec{b} \times \vec{c}}{\vec{a} \cdot (\vec{b} \times \vec{c})}$$

$$\vec{b}^* = \frac{\vec{c} \times \vec{a}}{\vec{a} \cdot (\vec{b} \times \vec{c})}$$

$$\vec{c}^* = \frac{\vec{a} \times \vec{b}}{\vec{a} \cdot (\vec{b} \times \vec{c})}$$